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Most Young Scholars Grant (Einstein Program):Advanced Functional Materials for High-Capacity Electrochemical Energy Storage

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Taiwan lacks natural resources and thus sustainability becomes extremely crucial. In order to comply with Taiwan's New Energy Policy, which is to reduce CO_2 emissions (regarded as the main cause of global warming and environmental pollution resulting from burning fossil fuel), green alternative renewable energy must be a top priority. In order to harness the full capacities of renewable energy sources, e.g., solar and wind power which are inherently intermittent, clean and sustainable energy storage is undoubtedly needed. Grid-scale energy storage is emerging as one of the largest potential applications for electrochemical devices and will require abundant, low-cost, ultra-stable electrodes. Increasing needs in high energy density and limited excess to lithium resources will require the discovery of new electrochemistry beyond lithium technology. New rechargeable battery systems based on multivalent cation charge carriers, such as Mg^{2+}, Zn^{2+}, Ca^{2+}, and Al^{3+} ions, which involve more than one electron transfer, have the promise to deliver higher specific capacity and energy density. However, in order to materialize these new energy storage technologies, several challenges must be overcome. The objective of my project is to design and develop advanced functional materials with complex nanostructures as electrode materials and solid-state electrolytes, which are the two most important components affecting the properties and electrochemical performance of high energy-density multivalent-ion batteries. My interests concern three distinct yet related areas: (1) conductive porous metal-organic frameworks for electrochemical energy storage, (2) conductive polymeric porous materials as battery electrodes, and (3) surface engineered materials for better electrochemical performance. The findings from this project will address a broad range of research challenges, from new materials discovery to energy storage. My research will uncover the relationships between materials properties, electrode architectures, and electrochemical mechanisms. I feel tremendously honored to be a MOST grant recipient for the Einstein Program to pursue this project. None of this would be possible without the support from Taiwan Ministry of Science and Technology (MOST). I have been fortunate to have great support from National Cheng Kung University. I sincerely thank all my wonderful colleagues at the Department of Chemical Engineering for their generous guidance.